NATIONAL, SECTORAL AND SPATIAL PERSPECTIVES ON TECHNICAL EFFICIENCY AND RETURNS TO SCALE IN INDONESIAN ECONOMY

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ABSTRACT

This paper presents the results of analysis on technical efficiency and return to scale in the Indonesia on the national, sectoral and spatial perspectives. National analysis was based on a macroeconomics cycles: oil booming phase (1967-1981), recession phase (1982-1986), deregulation phase (1987-1996), multi-dimension crisis phase (1997-2001) and economic recovery phase (2002-1013) and the government regime: the New order (1966-1998) and Reformation governments (1999-2014). Sectoral analysis was based on the 9 sectors classification, namely: Agriculture, Mining and Quarrying, Manufacturing, Electricity, Gas and Drinking Water, Construction, Trade, Hotel and Restaurant, Transportation and Communication, Finance, Rental and Corporate Services, and Services. Spatial analysis focused on seven groups of islands: Sumatera, Java, Kalimantan, Sulawesi, Bali-Nusa Tenggara, Maluku, and Papua. Cobb Douglass production function was employed to calculate technical efficiency and return to scale using regression analysis. Data on Gross Domestic Product, Capital stock and Employment of the year of 1967-2013 used for national analysis, data of year 1967-2007 for sectoral analysis and data of 1983-2013 for spatial analysis. The results show that firstly, technical efficiency during the New Order Government was better than those during Reformation Government. Secondly, those sectors in which the coefficients were above that at the national level, experienced decreasing returns to scale. On the contrary, those sectors in which the coefficients were below that at national level, experienced increasing returns to scale. Thirdly, the provinces with coefficients of technical efficiency below that at national level exhibited increasing returns to scale. Otherwise, the provinces with coefficients of technical efficiency above that at national level exhibited decreasing returns to scale.

Keywords: *Technical efficiency; return to scale; national; sectoral; spatial.*

1. INTRODUCTION

Economists have long recognized that technology is a factor of production, and even the most important factor, given its role in labor quality and the design of capital good. Technological advances play a crucial role in improving productivity and thus the standard of living of a system; economic system (Adam, 2006). Most economists today agree with the hypothesis that both innovation and technological spillovers was the main engine for explaining productivity growth.

Measuring the effect of technology on productivity is a difficult pursuit. It is generally approached through metrics such as Gross Domestic Product, GDP per capita and Total Factor Productivity (TFP). The former two attempt to capture the overall output of a given economy from a macro-environmental perspective. The latter is attempting to measure technologically driven advancement through noting increase in overall output without increases in input. This is done through utilizing production function equations and identifying when the output is greater than the supposed input, implying an advance in external technological environment (Boundless, 2016).

Technology can be regarded as primary resource in economic development. The level of technology is also an important determinant of economic growth. The rapid rate of growth can be achieved through high level of technology. It was observed that innovation or technological progress is the only determinant of economic progress. However if the level of technology becomes constant the process of growth will stops. Thus, it is the technological progress which keeps the economy moving. Inventions and innovations have been largely responsible for rapid economic growth in developed countries (Debasish, 2016).

In economics, the Cobb-Douglas production function is widely used to represent the relationship of an output to input (Bao Hong, 2008). It was proposed by Knut Wicksell (1851-1926) and tested against statistical evident by Charles Cobb and Paul Douglas in 1928. From Cobb-Douglas production function, technical efficiency also known as total factor productivity and returns to scale can easily be calculated by employing regression analysis (Salvatore, 1996).

Since the declaration of Indonesian independence on 17 August 1945, the Indonesian economy has been up and down, experiencing booming and recession (Galih Adhidarma, 2015). Economic cycle such as booming, recession and even economic crisis have been exist in the Indonesia economy. Socia Prihawantoro et al., (2009) have indicated that few phases in Indonesia economy during the year of 1967 to year 2013, namely: oil booming (1967-1981), recession (19082-1986), deregulation (1987-1996), multi-dimension economic crisis (1997-2001), and economic recovery (2002-2013). Indonesian economy during the era of New Order under Suharto presidency (1966-1998) and during the era of Reformation (1999-2014) run by Habibie Presidency (1998-1999), Wahid Presidency (1999-2001), Megawati Presidency (2001-2004) and Yudhoyono Presidency (2004-2014)has shown clearly the economy's business cycle, up and down over time.

Structural transformation process in the Indonesian economy is indicated initially by the dominance of agricultural sector both in output and in employment. The primary sector, namely: Agriculture and Mining-Quarrying dominated the Indonesian economy until 1987-1988, but Secondary (Manufacturing) and Tertiary Sectors (Trade, Hotel and Restaurant) have replaced this position after 1999 in term of output. But, in term of employment, data show that during the year of 1967 to 2007, Agriculture has still dominated the Indonesian economy.

According to the theory of location, it is reasonable view that economic growth unevenly happened in a national economy. Regional disparities do exist in Indonesia economy. There are some regions that grow

very fast and there are others that grow very slowly. In Indonesia, some provinces grow very fast such as provinces in Java Island and those in Sumatera Island. Some others grow very slowly, such as in West Nusa Tenggara and in East Nusa Tenggara.

Previous research on technical efficiency and return to scale, among others: Biresh K. S., at al., (2014), Krivonozhko,V. E. at al. (2007), Tewodros G. G. (2008), Feng, G and Serletis, A .(2010), Nondo, C. (2014), Holyk, S. (2016), Jatto. N. A. (2013), Page, J. M. Jr., (1980), Erkoc, T. E.(2012), Kui-Wai Li, at al. (2007), and Yudistira, D (2004). Measuring Indonesia's sectoral efficiencies has been conducted by Rizaldi Akbar (2015) and Muchdie, M. (2016). As far, no study on Indonesian's regional technical efficiency has been conducted.

The research reported in this paper aimed at analyzing the coefficient of technical efficiency and return to scale of the Indonesia economy during the era of New Order (1967-1998) and the era of Reformation (1999-2013). This time frame is also disaggregated into the phases of economic' cycles, such oil booming phase (1967-1981), recession phase (1982-1986), deregulations Phase (1987-1996), multi-dimension crisis phase (1997-2001) and economic recoveryphase (2002-1013). At sectoral level, the study focus on 9 sectors classification, namely : Agriculture, Mining and Quarrying, Manufacturing, Electricity, Gas and Drinking Water, Construction, Trade, Hotel and Restaurant, Transportation and Communication, Finance, Rental and Corporate Services, and Services. At spatial aspect, this study focus on seven groups of Islands, namely : Sumatera, Java, Kalimantan, Sulawesi, Bali-NusaTenggara, and Maluku and Papua.

2. METHODOLOGY

Cobb-Douglas production function, $Q = \gamma K^{\alpha} L^{\beta}$, was employed in this exercise to calculate technical efficiency (γ), returns to scale ($\alpha + \beta$), output-capital elasticity (α) and output-labor elasticity (β). This production function was developed and statistically tested by Cobb, C. & Douglas, P. (1927-1947), where:

Q = total production (the real value of all goods and services produced in a year;
K = capital input (the real value of all machinery, equipment, and building;
L = labor input (the total number of person-hours worked in a year;
γ = technical efficiency in production process, known as total factor productivity;
α = output-capital elasticity;
β = output-labor elasticity.

Technical efficiency (γ), or total factor productivity (TFP) is the portion of output not explained by the amount of input used in production (Comin, 2006). This is a method of measuring overall productivity of business, industries or economies. Technical efficiency is the effectiveness with which a given set inputs is used to produce an output. An economy is said to be technically efficient if an economy is producing the maximum output from the minimum quantity of inputs, such as labor, capital and technology. Technical efficiency is related to productive efficiency which is concern with producing at the lowest point on the short run average cost curve. Thus productive efficiency required technical efficiency (Pettinger, 2012).

The values of α and β are basically determined by available technology. Output elasticity measure the responsiveness of output to a change in levels either capital or labor used in production. Furthermore, if $\alpha + \beta = 1$, the production function has constant returns to scale, meaning that doubling the usage of capital (K) and

labor (L) will also double output (Q). If $\alpha + \beta < 1$, returns to scale are decreasing and if $\alpha + \beta > 1$, returns to scale are increasing.

The output elasticity of capital, $E_K = \delta Q/\delta K. K/Q = \alpha Q/K. /Q = \alpha$. Similarly, the output elasticity of labor, $E_L = \delta Q/\delta L.L/Q = \beta Q/L. L/Q = \beta$ and $E_K + E_L = \alpha + \beta$ = return to scale (Salvatore, 1996). Converting the production function from $Q = \gamma K^{\alpha} L^{\beta}$ in to a logarithms form that is, $\ln Q = \ln \gamma + \alpha \ln K + \beta \ln L$. As this is a linier form, then the coefficients (γ,α and β) can easily be estimated by regression analysis (Gaspersz. 1996). The Cobb-Douglas production function can be estimated either from data for a single firm, industry, region or nation over time using time-series analysis or for a single firm, industry, region or national one point in time using cross-sectional data (Salvatore, 1996).

Data needed for this exercise were sectoral data on Gross Domestic Regional Product, Regional Capital Stock and Regional Employment. Yearly data on GDRP, Regional Capital Stock and Regional Employment were collected from the National Statistics Agency. Data for analyzing technical efficiency at national level were for the year of 1967-2013. Meanwhile data for analyzing technical efficiency at sectoral level were data for the year of 1967-2007 and data for analyzing technical efficiency at spatial level were data for the year 2003-2013.

3. RESULTS AND DISCUSSIONS

Table 1 provided results of calculation using an easy and user friendly Excel software of Microsoft Office. Technical efficiency, or total factor productivity of the Indonesian economy during the year 1967 to year 2013, was 2.78. In the New Order era the coefficient was 3.08 which were higher than that of the Reformation Government, 2.98. It means that technological progress during the New Order era was better than that of the Reformation Government. Even, the progress of technical production was higher than that at the national level. Table 1 also shows that both during the two eras of Indonesian Government have experienced the decreasing returns to scale. The coefficients of returns to scale during the Reformation Government were 0.75 a bit higher than that of the New Order Government, 0.70. Both were a slightly lower compared to that at the national level (0.78).

Table 2 provides results of calculation from regression analysis. All the coefficients of technical efficiency during the Indonesia economics' business cycle were higher than that at national level (2.78). The technical efficiency coefficient at the recession phase (1982-1986) was 6.88 and at the multi-dimension crisis phase (1997-2011) was 5.86. These two coefficients were the highest. Except the coefficient of technical efficiency at the economic recovery phase (2.70), all of these coefficients were higher than that at the national level.

Table 3 presents the coefficients of technical efficiency and returns to scale during 1967 to 2007 both at national level and sectoral level. Technical efficiency in Indonesian economy during the year 1967 to 2007 was 2.77. At sectoral perspective the coefficients of technical efficiency vary among sectors. From 9 economic sectors, 4 sectors had coefficients of technical efficiency which were above of that at national level, and other 5 sectors were below that at the national level. The sectors which the coefficient of technical efficiency above of that at national level was: Electricity, Gas and Drinking Water (12.04), Mining and Quarrying (5.30), Construction (4.91), and Manufacturing (4.31). The sectors which the coefficient of technical efficiency below

of that at national level were: Financial, Rental and Corporate Services (-1.47), Agriculture (-0.69), Services (1.93), Trade, Hotel and Restaurant (2.49) and Transportation and Communication (2.72). It means that the technical efficiency of 4 sectors earlier were better than that at the national level. Meanwhile the coefficients of technical efficiency of 5 other sectors were worse than that at the national level. These 5 sectors should have got more attention by policy makers, especially those that the values of the coefficient were negative.

At national level, Indonesian economy experienced decreasing returns to scale. The coefficients of returns to scale vary among sectors, where 5 sectors were increasing returns to scale and 4 sectors were decreasing returns to scale. Five increasing returns to scale sectors were: Financial, Rental and Corporate Services (2.13), Services (1.32), Agriculture (1.20), Transportation and Communication (1.19), and Trade, Hotel and Restaurant (1.03). These 5 sectors experiencing increasing returns to scale were the sectors in which their coefficients of technical efficiency were below of that at the national level. Four decreasing returns to scale sectors were: Manufacturing (0.67), Mining and Quarrying (-0.23), Electricity, Gas, and Drinking Water (-0.34), and Construction (-1.14). Again, those sectors that had the coefficient of technical efficiency above that at national level experiencing decreasing returns to scale.

Figure 1 presents the quadrant of technical efficiency (above Versus below National Average) and returns to scale (Increasing Returns to Scale Versus Decreasing Returns to Scale). Four sectors in which the coefficients of technical efficiency were above that at national level also exhibiting decreasing returns to scale. Those sectors were: Mining and Quarrying, Manufacturing, Electricity, Gas and Drinking Water and Construction. Other five sectors in which the coefficients of technical efficiency were below that at national level, exhibiting increasing returns to scale. Those sectors were: Financial, Rental and Corporate Services, Services, Agriculture, Transportation and Communication, and Trade, Hotel and Restaurant.

Figure 2 presents the quadrant of technical efficiency's coefficient (above and below that at national level) and returns to scale (increasing and decreasing returns to scale). The group of islands with the coefficients of technical efficiency that was higher than that at national level also exhibited decreasing returns to scale. These groups of islands were Kalimantan, Maluku and Papua. The others with the coefficient of technical efficiency less than that at national level and exhibited increasing returns to scale were Sumatera, Java, Sulawesi and Bali-Nusa Tenggara.

As shown in Figure 3, provinces in which the coefficient of technical efficiency above that at national level and exhibiting decreasing returns to scale were: Nangro Aceh Darussalam, North Sumatera, Riau, The Island of Riau, South Sumatera, Bangka-Belitung, Yogyakarta, South Kalimantan, East Kalimantan, Gorontalo, Bali, Maluku, North Maluku and Papua. Other provinces in which the coefficients of technical efficiency below that at national level and exhibiting increasing returns to scale were : West Sumatera, Jambi, Bengkulu, Lampung, Jakarta Capital City, Banten, West Java, Central Java, East Java, West Kalimantan, Central Kalimantan, North Sulawesi, Central Sulawesi, South-East Sulawesi, West Sulawesi, South Sulawesi, West Nusa Tenggara, East Nusa Tenggara, and West Papua.

The study of technical efficiency and returns to scale usually conducted in a firm or industry level as technical production was more homogeneous at the firm level. In the national, sectoral and spatial economy, there might be a risk in aggregating technology. The different time fame of the study is another limitation of the study.

4. CONCLUSION

From above discussions, it could be concluded that firstly, at national perspective, technical efficiency during the New Order Government was better than those during Reformation Government. Secondly, at sectoral level, those sectors in which the coefficients were above that at the national level, experienced decreasing returns to scale. On the contrary, those sectors in which the coefficients were below that at national level, experienced increasing returns to scale. Thirdly, at spatial perspective, the provinces with coefficients of technical efficiency below that at national level exhibited increasing returns to scale. Otherwise, the provinces with coefficients of technical efficiency above that at national level exhibited decreasing returns to scale.

It could be suggested that the sectors or provinces with the coefficients of technical efficiency higher than that at the national level not to increase the inputs of production as the economy experiencing decreasing returns to scale. Meanwhile the sector or provinces that had the coefficients of technical efficiency lower than that at the national level to increase all inputs in production in order to increase output as the economy experiencing increasing returns to scale.

5. REFERENCES

Adams, J. (2006).The Contribution of Science and Technology to Production. the National Bureau of Economic Research. Cambridge Massachusett.

Bao Hong, T. (2008). Cobb-Douglas Production Function. retrieved on 22 June 2016 from http:// docentes.fe. unl.pt/jamador/Macro/cobb-douglas.pdf

Biresh K. Sahoo, Joe Zhu, Kaoru Tone, Bernhard M. Klemen, (2014). Decomposing technical efficiency and scale elasticity in two-stage network DEA.European Journal of Operational Research.Volume 233, Issue 3, 584–594.

Boundless,(2016). Impacts of Technological Change on Productivity.Boundless economics, 26 May 2016. Retrieved 22 June 2016 from https://www.boundless.com/economics/texbook/boundless-economics-texbook/economic-growth-20/productivity-98/impacts-of-technological-change-on-productivity-370-12467/

Cobb C.W, and Douglas, P.H. (1928). A Theory of Production. American Economic Review 18 (Supplement). 139-165.

Comin, D., (2006). Total Factor Productivity. New York University. New York.

Debasish,(2016). Role of Technology in Economic Development. Economicsdiscussion.net.Retrievedon 22 June 2016 from http://www.economicsdiscussion.net/articles/role-of-technoloy-in-economic-development/ 4455.

Erkoc, T. E. (2012).Estimation Methodology of Economic Efficiency: Stochastic Frontier Analysis versus Data Envelopment Analysis. International Journal of Academic Research in Economics and Management Sciences. January 2012, Volume1, No. 1, 1-23.

Feng, G and Serletis, A. (2010). Efficiency, Technical Change, and Returns to Scale in Large US Banks: Panel Data Evidence from an Output Distance Function Satisfying Theoretical Regularity.Journal of Banking & Finance 34(1), 127-138.

Galih Adhidarma. (2015). Analisis Siklus Bisnis dan Indikator Ekonomi Pendahulu Indonesia Tahun 2000:Q2 –2012:Q3. MacroEconomics DashBoard. Fakultas Ekonomika dan Bisnis UGM. Available at http://macroeconomicdashboard.feb.ugm.ac.id/analisis-siklus-bisnis-dan-indikator-ekonomi-pendahulu-indonesia-tahun-2000q2-2012q3/, accessed on 4 Juni 2016.

Gaspersz. V. (1996). Ekonomi Manajerial, Penerapan Konsep-Konsep Ekonomi DalamManajemen Bisnis Total (Mangerial Economics : Application of Economic Concepts in Total Business Management). PT Gramedia Pustaka Utama, Jakarta.

Gebreselasie, T.G.(2008). Sectoral Elasticity of Substitution and Returns to Scale in South Africa.South African Journal of Economics.Special Issue: Industrial growth and employment in South Africa,Volume 76, Issue Supplement s2, S110–S125.

Holyk, S., (2016). Measuring Technical Efficiency and Economy on Scale in Finnish Food Processing Industry. International Journal of Science: Basic and Applied Research.Volume 27, No 3, 226-238.

Jatto, N.A., (2013).Assessing the Return to Scale: Evidence from Fish Farmers in Ilorin. Kwara State. Russian Journal of Agricultural and Socio-Economic Sciences, 1(13), 56-59.

Krivonozhko, V. E., Dvorkovich, A. V. ,Utkin, O. B. , Zharkov I. D, Patrin, M. V. and Lyche A. V. (2007). Computation of elasticity and scale effect in technical efficiency analysis of complex systems.Computational Mathematics and Modeling.Volume 18, Issue 4, 432-452.

Kui-Wai Li, Tung Liu, and Lihong Yun., (2007). Technology Progress, Efficiency, and Scale of Economy in Post-reform China.Working Paper.Department of Economics and Finance. City University of Hong Kong, Hong Kong.

Muchdie, M., (2016). Sectoral Variation on Technical Efficiency and Return to Scale in the Indonesian Economy. Signifikan Jurnal Ilmu Ekonomi. Volume 5 No.2., 119-132.

Nondo, C. (2014). Evaluating the technical efficiency of African economies using DEA and the bootstrap approach.African Journal of Economic and Sustainable Development. Volume 3, Issue 2 , 156-178.

Ondrej, M. (2012). Data Issued in Total Factor Productivity Benchmarking : A Central European Perspective. University Economics in Praque. Faculty of Business Administration Working Paper, 219-225.

Page, J. M. Jr. (1980).Technical Efficiency and Economic Performance: Some Evidence from Ghana, Oxford Economic Papers. New Series, Volume 32, No. 2, 319-339.

Pettinger, T., (2012). Technical Efficiency Definition. Get Economic Help in www.economichelp. org/blog/glossary/technical-efficiency.

Rizaldi Akbar. (2015). Measuring Indonesia's Sectoral Efficiencies : A Data Envelopment Analysis Approach. Working Paper, University of Western Australia.

Salvatore, D., (1996). Managerial Economic in a Global Economy. Irwin McGraw Hill, Boston.

Socia Prihawantoro, Irawan Suryawijaya, Ramos Hutapea, Ugay Sugarmansyah, Alkadri Wawan Rusiawan, dan Muhammad Yorga Permana., (2013). Peranan Teknologi Dalam Pertumbuhan Koridor-Koridor Ekonomi Indonesia: Pendekatan Total Factor Productivity (The Role of Technology in Economic Growth in Indonesian Economic Corridors: Total Factor Productivity Approach). Badan Pengkajian dan Penerapan Teknologi, Jakarta.

Socia Prihawantoro, Alkadri, Mien Askinatin, Andi Tabrani, Supomo, Abd Azis Wasil.(2009). Peran Teknologi dalam Pertumbuhan Ekonomi Indonesia (*The Role of Technology in the Indonesian Economic Growth)*. Badan Pengkajian dan Penerapan Teknologi. Jakarta.

Wikipedia. (2016).Post Suharto Era, retrived on 22 June 2016 from https:en.wikipedia.org/wiki/Post-Suharto_era.

Yudistira, D. (2004).Efficiency in Islamic Banking: An Empirical Analysis of Eighteen Banks. Islamic Economic Studies. Volume. 12, No. 1, 1-19.

Table 1: Coefficient of Technical Efficiency (TE) and Returns to Scale (RTS) during The New Order and the Reformation Governments.

Indonesian Economy	***TE***	***RTS***
All Period (1967-2013)	2.78	0.78
New Order Government (1967-1998)	3.08	0.70
Reformation Era Government (1999-2013)	2.98	0.75

Source: Data Analysis

Table 2: Coefficient of Technical Efficiency (TE) and Returns to Scale (RTS) Based on the Indonesia Economy's Cycles.

Indonesia Economy's Cycle	***TE***	***RTS***
All Phases (1967-2013)	2.78	0.78
Oil Boom Phase (1976-1981)	3.78	0.57
Recession Phase (1982-1986)	6.88	-0.13
Deregulation Phase (1987-1996)	2.80	0.71
Multi-dimension Crisis Phase (1997-2001)	5.86	0.24
Economic Recovery Phase (2002-2013)	2.70	0.80

Source: Data Analysis

Table3 Coefficients of Technical Efficiency (TE) and Return to Scale (RTS) Based on Economic' Sectoral Activities.

Sectoral Analysis	***TE***	***RTS***
National Average	2.77	0.78
Agriculture	-0.69	1.20
Mining and Quarrying	5.30	-0.23
Manufacturing	4.31	0.67
Electricity Gas Drinking Water	12.04	-0.38
Construction	4.91	-1.17
Trade, Hotel & Restaurant	2.49	1.03
Transportation & Communication	2.72	1.19
Financial, Rental & Coorporate Services	-1.47	2.13
Services	1.93	1.32

Source: Data Analysis

Technical Efficiency	***Increasing Returns to Scale***	***Decreasing Returns to Scale***
Above National		Mining and Quarrying Manufacturing Electricity, Gas and Drinking Water Construction
Below National	Financial, Rental and Corporate Services Services Agriculture Transportation and Communication Trade, Hotel and Restaurant	

Figure 1: Quadrant of Technical Efficiency (TE) and Returns to Scale (RTS): Sectoral Level.

Technical efficiency	***Increasing Returns to Scale***	***Decreasing Returns to Scale***
Above national		Kalimantan Island Maluku Islands Papua Island
Below national	Sumatera Island Java Island Sulawesi Island Bali-Nusa Tenggara Islands	

Figure 2: Quadrant Technical Efficiency (TE) and Returns to Scale (RTS): Seven Big Islands.

Technical efficiency	***Increasing Returns to Scale***	***Decreasing Returns to Scale***
Above national		Nangro Aceh Darussalam North Sumatera Riau The Island of Riau South Sumatera Bangka-Belitung Yogyakarta South Kalimantan East Kalimantan Gorontalo Bali Maluku North Maluku Papua
Below national	West Sumatera Jambi Bengkulu Lampung Jakarta Capital City Banten West Java Central Java East Java West Kalimantan Central Kalimantan North Sulawesi Central Sulawesi South-East Sulawesi West Sulawesi South Sulawesi West Nusa Tenggara East Nusa Tenggara West Papua	

Figure 3: Quandrant of Technical Efficiency (TE) and Returns to Scale (RTS): Provincial Level.